Studying the Origin of Kuroshio with an Array of ADCP-TC Moorings

Ren-Chieh Lien
Applied Physics Laboratory
University of Washington
1013 NE 40th Street
Seattle, Washington 98105
Phone: (206) 685-1079 fax: (206) 543-6785 email: lien@apl.washington.edu

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LONG-TERM GOALS

Our long-term scientific goals are to understand the dynamics and identify mechanisms of small-scale processes—i.e., internal tides, inertial waves, nonlinear internal waves (NLIWs), and turbulence mixing—in the ocean and their interaction with mesoscale processes such as western boundary currents. We aim to develop improved parameterizations of mixing for ocean models. For this study, our focus is on the origin of the Kuroshio, the interaction among internal tides, internal waves, mesoscale eddies, and the Kuroshio, and the interaction of oceanic processes with the complex topography in Luzon Strait.

OBJECTIVES

The primary objectives of this observational program are to quantify the origin of the Kuroshio and quantify its properties at the origin and as it evolves downstream.

APPROACH

An array of three or four subsurface moorings will be maintained for about 1 year northeast of the Philippines, where the strong Kuroshio enters Luzon Strait. Each mooring will have an ADCP and a chain of CTD sensors to measure the velocity field, temperature, and salinity in the upper 600 m. We propose to service the moorings and conduct a shipboard survey every 6 months. Our long-term velocity, temperature, and salinity observations will help identify the origin and properties of the Kuroshio before it enters Luzon Strait. We will compare our observations with glider observations and with downstream mooring observations east of Taiwan to quantify the evolution of the Kuroshio.

WORK COMPLETED

In FY10 we attended one ONR workshop in Taiwan and one video conference workshop among U.S. and Taiwanese PIs in April 2010. A preliminary plan of the integrated observational program has been established. The tentative mooring array is described in Fig. 1. In this plan, arrays of two and three moorings and an array of five H-PIES will be deployed in the Luzon Strait. These moorings will be maintained for 1 year and serviced every 6 months.

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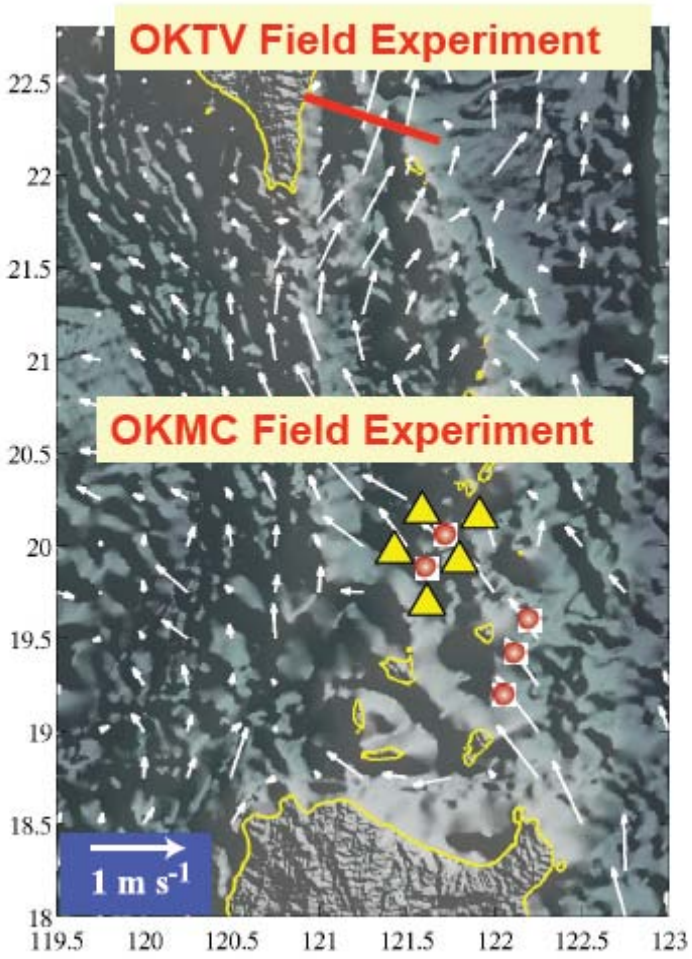

Figure 1. The tentative plan of ADCP-CTD moorings (red bullets) and H-PIES (yellow triangles) for the OKMC experiment. The five vectors are the composite shipboard ADCP velocity at 100-m depth. The red line is the possible Taiwanese mooring line.

IMPACT/APPLICATION

The Kuroshio is well defined north of the Luzon Strait as a strong western boundary current. Nonetheless, its origin and the dynamics of its initiation are not well understood. The potential origin of the Kuroshio is complicated by a rich spectrum of oceanic processes, e.g., remotely and locally generated eddies. The Kuroshio carries significant mass, heat, and energy from the tropics to subtropics and interacts with marginal seas. Therefore it is crucial to understand its origin and dynamics.

RELATED PROJECTS

Energy Budget of Nonlinear Internal Waves near Dongsha (N00014-05-1-0284) as a part of NLIWI DRI: In this project, we study the dynamics and quantify the energy budget of nonlinear internal waves (NLIWs) in the South China Sea using observations taken from two intensive shipboard experiments in 2005 and 2007 and a set of nearly one-year velocity-profile measurements taken in

2006–2007 from three bottom-mounted ADCPs across the continental slope east of Dongsha Plateau in the South China Sea. Results of the NLIWI DRI will help improve our understanding of the dynamics of NLIWs and will apply to the present project.

Study of Kuroshio Intrusion and Transport Using Moorings, HPIES, and EM-APEX Floats (N00014-08-1-0558) as a part of QPE DRI: The primary objectives of this observational program are 1) to quantify and to understand the dynamics of the Kuroshio intrusion and its migration into the southern East China Sea (SECS), 2) to identify the generation mechanisms of the Cold Dome often found on the SECS, 3) to quantify the internal tidal energy flux and budgets on the SECS and study the effects of the Kuroshio front on the internal tidal energy flux, 4) to quantify NLIWs and provide statistical properties of NLIWs in the SECS , and 5) to provide our results to acoustic investigators to assess the uncertainty in acoustic predictions. Results of the NLIWI DRI will provide a better understanding of the dynamics of NLIWs that have strong effects on acoustic propagation and sonar performance.

Process Study of Oceanic Responses to Typhoons Using Arrays of EM-APEX Floats and Moorings (N00014-08-1-0560) as a part of ITOP DRI: We will study the dynamics of the oceanic response to and recovery from tropical cyclones in the western Pacific using long-term mooring observations and an array of EM-APEX floats. Pacific typhoons may cause cold pools on the continental shelf of the East China Sea. The cold pool dynamics are likely related to the Kuroshio and its intrusion as well as the shelf/slope oceanic processes.